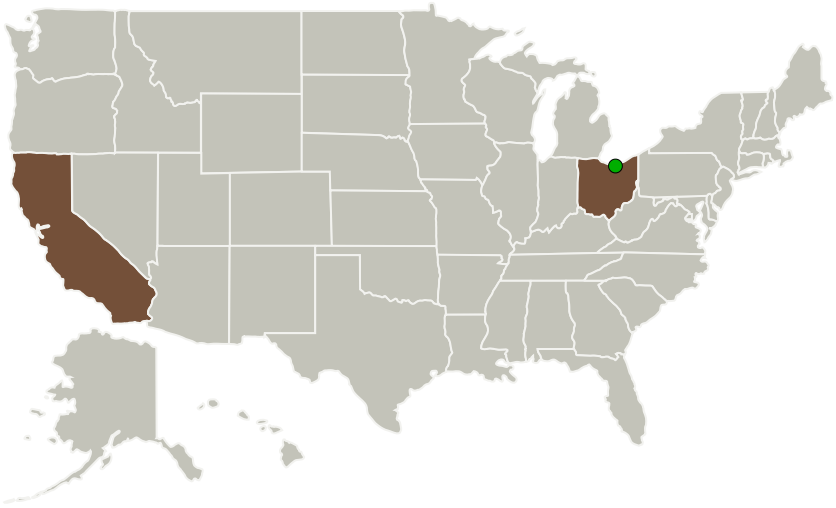
Spectrally Matched Wideband Metamaterial Emitters for High Power and Efficient Thermophotovoltaic Converters, Phase I

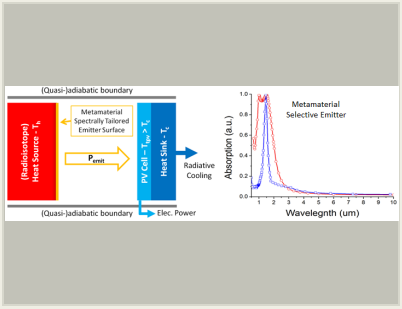
Completed Technology Project (2014 - 2014)

Project Introduction

A thermophotovoltaic (TPV) system is a promising energy conversion device that generates the electric power from short wave infrared (SWIR) thermal radiation. However, it's low power throughput and poor conversion efficiency restricts the usage in practical applications. One solution for resolving these issues is to utilize a metamaterial emitter whose thermal emission band is spectrally matched to the energy conversion band of the TPV cell. However, typical frequency selective emitters (SE) emit only in a narrow frequency band, limiting the total power throughput of the TPV system. This proposal thus aims to experimentally investigate wideband metamaterial emitters, whose emission band is spectrally matched and utilizes the entire energy conversion band of the TPV cell. The innovative aspects of the proposed research are (1) to develop robust electromagnetic numerical simulation capabilities that incorporate experimentally measured material properties as a function of frequency, and device operation temperature into the design of the metamaterial emitter; (2) incorporate novel metal-nitride materials into the metamaterial structure, enabling optical property tunability through stoichiometric control, and wideband, spectrally matched thermal emission; (3) to fabricate and characterize a metamaterial emitter whose thermal emission band is spectrally matched to the energy conversion band of the target TPV cell. By improving not only the overall efficiency of TPV converters, but importantly the total power throughput, this technology will enable more efficient, compact electrical energy sources for a range of applications, which include power sources for rural and remote locations, solar power generation, waste heat recovery, and power sources for deep space exploration.

Primary U.S. Work Locations and Key Partners





Spectrally Matched Wideband Metamaterial Emitters for High Power and Efficient Thermophotovoltaic Converters Project Image

Table of Contents

Small Business Innovation Research/Small Business Tech Transfer

Spectrally Matched Wideband Metamaterial Emitters for High Power and Efficient Thermophotovoltaic Converters, Phase I

Completed Technology Project (2014 - 2014)

Organizations Performing Work	Role	Type	Location
SensorMetrix	Lead Organization	Industry	San Diego, California
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
California	Ohio

Project Transitions

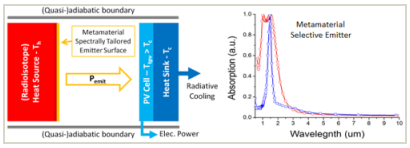
June 2014: Project Start

December 2014: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137653)*

Images



Project Image
Spectrally Matched Wideband Metamaterial Emitters for High Power and Efficient Thermophotovoltaic Converters Project Image *(https://techport.nasa.gov/image/136242)*

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Organization:
SensorMetrix

Responsible Program:
Small Business Innovation Research/Small Business Tech Transfer

Project Management

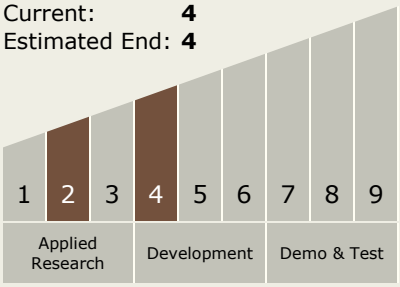
Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
Anthony Starr

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



Spectrally Matched Wideband Metamaterial Emitters for High Power and Efficient Thermophotovoltaic Converters, Phase I

Completed Technology Project (2014 - 2014)

Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
  - TX03.1 Power Generation and Energy Conversion
    - TX03.1.1 Photovoltaic

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System